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THE GROWTH OF THE WHEAT SCAB ORGANISM IN RELATION TO HYDROGEN-ION CONCENTRATION

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THE GROWTH OF THE WHEAT SCAB ORGANISM IN RELATION TO HYDROGEN-ION CONCENTRATION.

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WITH ONE FIGURE IN THE TEXT

A strain of Fusarium, isolated from scabby wheat in Minnesota, has been found to be capable of growing in solutions varying through an

TABLE 1

Character of growth of the wheat scab organism in relation to hydrogen ion concentration

	Buffer solution (c. c.)		Sodium hydroxide (c.c.—1N)		Distilled water (c. c.)		Czapek's solution (c. c.)		Initial pH[2]		Character of growth[3]	
Expt. No. Flask No.	1	2	1	2	1	2	1	2	1	2	1	2
1	1	1	0	0	35	45	10	10	3.0	3.0	very slow	very slow
2	1	1	5	5	30	40	10	10	3.5	3.9	slow	slow
3	1	1	10	10	25	35	10	10	4.6	4.9	good	good
4	1	1	15	15	20	30	10	10	5.8	6.	good	good
5	1	1	20	20	15	25	10	10	7.2	7.1	good	good
6	1	1	25	25	10	20	10	10	9.0	9.8	good	good
7	1	1	30	30	5	15	10	10	10.6	?	slow	slow
8		1	35	35	0	10	10	10	12.0[1]	11.7	very slow	very slow
9	–	1	–	40	–	5	–	10	–	11.9	–	none
10	–	1	–	45	–	0	–	10	–	12.1	–	none

[1] Approximate.

[2] Average of at least 2 determinations.

[3] Experiment 1 run in triplicate, Experiment 2 with 6 similar flasks for each set.

unusually wide range of hydrogen-ion concentration. The organism grew in nutrient media ranging from pH 3.0 to pH 11.7 (Tab. 1). Definite results have not yet been obtained for concentrations immediately below pH 3.0 or above 11.7, but indications are that these figures are close to the acid and alkaline limit for growth.

The organism was grown in a modified Czapek's solution[1] to which a mixed buffer solution was added, the pH being varied by the addition of increasing amounts of sodium hydroxide.[2] The buffer solution was made up as follows:

5.252 gm.	citric acid
1.876 gm.	glycocoll
2.269 gm.	KH_2PO_4
50 cc.	distilled water

The various constituents of the medium were sterilized before mixing in order to prevent the breaking down of the sugar which takes place in the more alkaline solutions when heated.

The solutions, in 56 c. c. portions, were mixed in sterile flasks of 150 c. c. capacity and left to incubate for at least 24 hours in order to insure sterility. Flasks showing cloudiness or other contaminations were discarded. The inoculations were made with young rapidly growing mycelium of the organism taken from potato dextrose slants. Uninoculated flasks, in general, remained sterile throughout the two or three weeks during which the experiments were conducted.

The hydrogen-ion concentration of the solutions was determined at the beginning of the experiments and at various intervals thereafter by means of a Clark (4) hydrogen electrode, including the shaking cell as described by him. As growth proceeds, the hydrogen-ion concentration of the solutions is changed by the organism, those on the acid side tending to become more alkaline and those on the alkaline side more acid. Further work on the change of pH by the organism is in progress.

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[1] Modified Czapek's solution as used:

$MgSO_4$	1.0 gm.
KC	1.0 gm.
$FeSO_4$	0.02gm.
$NaNO_3$	4.0 gm.
Sugar	30.0 gm.

Distilled water 1 liter.

Sterilized at 5 lbs. pressure for one half hour.

(The phosphate was omitted due to its presence in the buffer solution).

[2] The sodium hydroxide stock solution was prepared in the manner suggested by Clark (4), in order to prevent the formation of carbonates by the exposure to the CO_2 of the air.

It is interesting to compare the pH range of this organism with that of other micro-organisms. Hopkins (10), working with a wheat scab organism (*Gibberella saubinetii*), obtained growth in nutrient solutions varying in hydrogen-ion concentration from pH 2.5 to pH 5.5, the upper limit not being determined. Brightman, Meachem, and Acree (2) found that the organism which causes chestnut blight (*Endothia parasitica*) grew in solutions varying in hydrogen-ion concentration from pH 4.0 to pH 8.5. Wakeman (18) in determining the changes in reaction due to the growth of Actinomycetes, found that the acid and alkaline limits for growth were between pH 5.0 and pH 8.7, varying somewhat with the species. Meacham (15) found that four common wood destroying fungi develop normally in media having a very high acidity (pH 1.7) but no data are given for the alkaline limit. *Aspergillus niger* is reported by Currie (5) to grow at pH 1.4–1.6, the critical alkaline concentration not being determined.

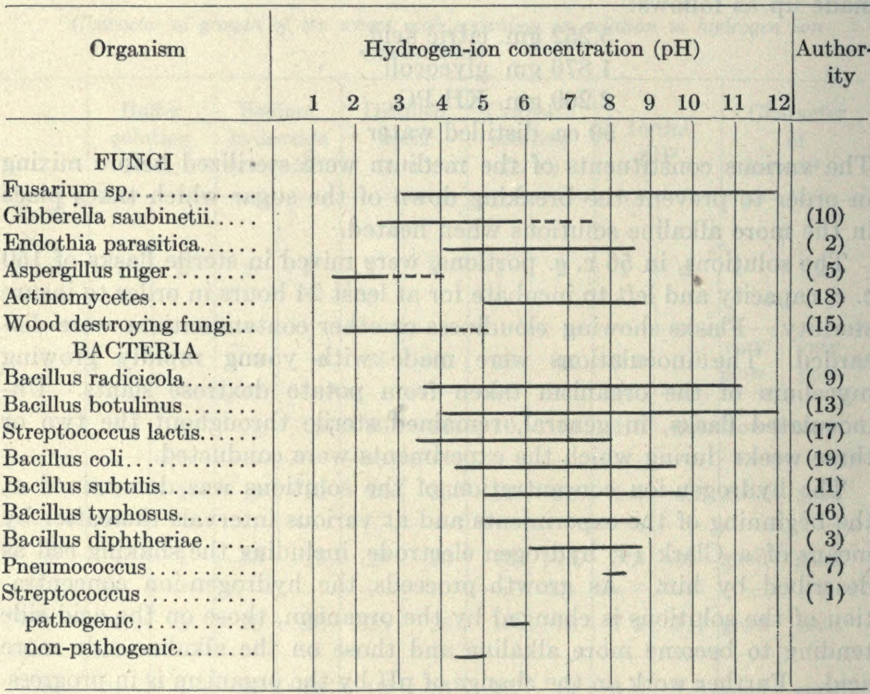

FIG. 1. The Relation of a Number of Pathogenic Micro-organisms to Hydrogen-ion Concentration.

Much more work has been done with bacteria in connection with tolerance to hydrogen-ion concentration, especially those bacteria causing human and animal diseases. An excellent summary of this work is given in a recent article by Dernby (6), in which he shows that none of these organisms will grow in a medium more acid than pH 4.5 or more alkaline than pH 9.0. Fred and Loomis (9), on the other hand, found that *Bacillus radicicola* developed normally at all hydrogen-ion concentrations between pH 3.5 and pH 11.1. The only other reference to organisms tolerating as wide a range of hydrogen-ion concentration as that of the Fusarium reported in this paper is that of Itano, Neill, and Garvey (13). Some strains of *Bacillus botulinus* were found by them to grow in acid solutions of pH 4.0, while others would not grow in solutions more acid than pH 6.0. On the alkaline side, some strains would develop normally at pH 12.0 but others not above pH 9.0. According to Wyeth (19) *Bacillus coli* can grow at pH 4.27 to pH 9.87, and Itano (11) has given the range for *Bacillus subtilis* as being from pH 5.0 to pH 10.0. On the other hand, the more highly specialized Streptococci studied by Ayers, Johnson, and Davis (1) have been found extremely sensitive to slight changes in hydrogen-ion concentration and to develop normally only between pH 5.4 and 6.0.

A graphic representation of the acid and alkaline limits of a number of common bacteria and of all the fungi mentioned above is given in figure 1. It is evident that the organism used in these experiments is exceptional, particularly among the fungi, in the wide range of hydrogen-ion concentration in which it will grow. This organism is known to be capable of attacking a very large number of hosts.[1] If other more specialized Fusaria are shown to be more limited in their relations to hydrogen-ion concentration these results would seem to be of special significance.

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